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Tack Coat Adhesion

Prepared for
WHRP Flexible Pavements
Technical Oversight Committee

Prepared by
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WisDOT Research & Library Unit

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Topic/Problem Statement: Document literature from 2000 to the present relevant to a new laboratory-oriented study investigating tack coat adhesion properties and performance using materials common in Wisconsin paving.

Keywords: Tack, coat, adhesion, performance, interlayer, interface, asphalt, bond.

Summary

We found 13 reports and academic articles on relevant interlayer bonding and tack coat performance issues published since 2001, as well as five studies in progress. The bulk of the research has been recent, with one Wisconsin study in 2007; four publications in 2006, including a Washington state study, a TRB paper, and two journal articles; and four publications in 2005, including a Louisiana study, two academic journal articles, and a TRB article. From 2001 through 2004 we found one publication each year: TRB articles in 2001 and 2002, a 2003 journal article, and a 2004 study from Mississippi.

The five studies in progress come from across the country. Studies are being conducted in Washington, Louisiana, Arkansas, Alabama and Virginia.

Citations

Results are listed chronologically, with the most recent citations shown first. Links to online copies of cited literature are provided when available. Contact the WisDOT Library to obtain hard copies of citations.

Title: Evaluation of Interlayer Bonding in HMA Pavements
Author(s): Yusuf Mehta, Nusrat Siraj
Date: December 2007
Source/URL: WHRP 0092-02-13, Final Report, December 2007.
http://www.whrp.org/Research/Flex/flex_0092-02-13/02-13_Final_Report
Description: 144 pp.
Contents: Some states, such as Wisconsin DOT have experienced pavement failures that were attributed to poor bonding at the interlayer. Three roads of WisDOT were analyzed in this study, which experienced varied degrees of

slippage distress. The effect of slip can be minimized by making the surface layer sufficiently thick or stiff. It was observed that the stiffness ratio between the top two layers was higher for no distress sections than that of high distress sections. The additional thickness needed to increase structural capacity of a pavement with lower stiffness ratio to a level that will minimize slippage cracking was also investigated. The structural capacity of pavement with lower stiffness ratio (E1/E2 = 2) can be changed to the same structural capacity as that of a pavement with high E1/E2 (say, E1/E2 = 10) by providing additional thickness of 2 in and 4 in on existing top layer of 2 in and 3 in thickness, respectively. This study provides the state agency with tools during pavement design to minimize slippage cracking due to interlayer bonding failure.

Title: Evaluation of the Influence of Tack Coat Construction Factors on the Bond Strength Between Pavement Layers
Author(s): Laith Tashman, Kitae Nam, Tom Papagiannakis
Date: August 2006
Source/URL: Report No. WA-RD 645.1, Aug. 2006.
http://www.wsdot.wa.gov/research/reports/fullreports/645.1.pdf
Description: 91 pp.
Contents: This study investigated the influence of several factors on the adhesive bond provided by the tack coat at the interface between pavement layers. These factors included the surface treatment, curing time, residual application rate, and coring location. Three tests were performed for measuring the bond strength between an existing hot mix asphalt (HMA) and a new HMA overlay, namely the Florida DOT Shear Tester, the UTEP Pull Off Test, and the Torque Bond Test. Testing involved a CSS-1 type emulsion as the tack coat. The results from the three tests were statistically analyzed. Generally, milling provided a significantly better bond at the interface between the existing surface and the new overlay. Curing time had a minimal effect on the bond strength. The results indicated that the absence of tack coat did not significantly affect the bond strength at the interface for the milled sections, whereas it severely decreased the strength for the non-milled sections. The results also showed that increasing the residual rate of tack coat did not significantly change the bond strength at the interface. Lastly, the coring location was found to be an insignificant factor.

Title: Properties of asphalt concrete layer interfaces
Author(s): Mariana R. Kruntcheva, Andrew C. Collop, Nicholas H. Thom
Date: May 2006
Source/URL: *Journal of Materials in Civil Engineering*, Vol. 18 (3), 2006: 467-471.
Description: 5 pp.
Contents: This note outlines the experimental investigation of the factors affecting bond development between pavement layers. The tests involved the use of an apparatus known as the Nottingham shear box. To establish a realistic stress distribution at the interface, which would facilitate the analysis of the test results, finite element models of bonded and weakly bonded specimens were developed. It was concluded that care must be taken when interpreting test results from the shear box experiments. Several materials and four interface conditions were investigated. Bond stiffness and strength were assessed under repeated dynamic and monotonic static test conditions. The analysis of the experimental results showed that the interface properties depend more seriously on the type of materials in contact, rather than on the amount of the applied tack coat and the interface condition. It was suggested that the interface bond should be described by introducing a vertical shear reaction modulus, as well as using the horizontal shear reaction modulus.

Title: Evaluation of effect of heat-adhesive emulsions for tack coats with shear test: From the Road Research Laboratory of Barcelona
Author(s): Rodrigo Miro Recasens, Adriana Martínez, Felix Perez Jimenez
Date: 2006
Source/URL: *Transportation Research Record No. 1970*, 2006: 64-70.
Description: 7 pp.
Contents: The use of conventional emulsions for tack coats can cause problems since they frequently stick to the tires of construction vehicles. Consequently the bond between the asphalt layers is inadequate. The importance of tack coats in pavement performance means that bituminous emulsions are constantly being improved. Recently new types of emulsions have been developed from low penetration bitumen that contains no flux. These emulsions are known as heat-adhesive emulsions, and they are resistant to construction vehicles. The purpose of this study is to analyze the effect of different heat-adhesive emulsions and to verify their performance in service in comparison with the response of a conventional emulsion. For this reason a new shear test was developed in the Road Research Laboratory [Laboratorio de Caminos de Barcelona (LCB)] of the Technical University of Catalonia, in Barcelona, Spain. The LCB test is carried out at different temperatures, both on laboratory specimens and on cores extracted

from recently constructed pavements, in which the same emulsions and dosages have been used. The application of the LCB test shows that the performance of the different heat-adhesive emulsions mainly depends on the characteristics of the base bitumen and the kind of modifier used. At low temperatures, heat-adhesive emulsions reach, in general terms, lower shear resistances than those of conventional emulsions; however, at intermediate temperatures there are heat-adhesive emulsions with both higher and lower strengths than those of the conventional emulsions.

Title: Evaluating tack coat applications and the bond strength between pavement layers
Author(s): Randy C. West, Jason R. Moore, Jingna Zhang
Date: 2006
Source/URL: *Proceedings of the 2006 Airfield and Highway Pavement Specialty Conference*, Vol. 2006: 578-588.
Description: 11 pp.
Contents: Poor bond between two layers of hot mix asphalt (HMA) is the cause of many highway and airfield pavement problems. Slippage cracks, which often occur at locations where vehicles turn, accelerate, or decelerate, are the most commonly observed problem related to poor bond between layers. Other pavement problems may also be attributed to insufficient bond between layers of HMA. Compaction difficulty, premature fatigue, top down cracking, and surface layer delamination have also been linked to poor bond between HMA layers. This study included the evaluation of test conditions for measuring the bond strength between pavement layers. Bond strengths between HMA layers bonded with different tack coat materials and application rates were investigated. The laboratory experiment evaluated effects of tack coat type, application rate, mixture type, testing temperature and normal pressure on the bond strength. It was found that all of the main factors affected bond strength. Testing temperature had the greatest effect on bond strength. As the temperature increases, bond strength decreases significantly. Normal pressure affected bond strength more at the high test temperature. The effects of tack coat type and application rates on bond strengths are different for the fine-graded and coarse-graded mixtures. Based on the laboratory study, the best conditions for the method for determining the bond strength between pavement layers were selected.

Title: Investigation of the Behavior of Asphalt Tack Interface Layer
Author(s): Louay N. Mohammad, Zhong Wu, M. Abdur Raqib
Date: August 2005
Source/URL: LTRC Project No. 00-2B, Final Report (FHWA/LA.04/394).
http://www.ltrc.lsu.edu/pdf/2005/fr_394.pdf
Description: 126 pp.
Contents: Asphalt tack coat is a light application of asphalt, usually asphalt diluted with water. It ensures a bond between the surface being paved and the overlying course by providing increased shear strength between two interfaces. Normally, hot asphalt cements, emulsified asphalts or cutback asphalts are used as tack coat. The objective of this study was to evaluate the practice of using tack coats through controlled laboratory simple shear tests and determine the optimum application rate. The influence of tack coat types, application rates, and test temperatures on the interface shear strength was examined. Six emulsions (CRS-2P, CRS-2L, SS-1, CSS-1, SS-1h and SS-1L) and two asphalt binders (PG 64-22 and PG 76- 22M) were selected as tack coat materials. The residual application rates considered were 0.00 l/m2 (0.00 gal/yd2), 0.09 l/m2 (0.02 gal/yd2), 0.23 l/m2 (0.05 gal/yd2), 0.45 l/m2 (0.1 gal/yd2), and 0.9 l/m2 (0.2 gal/yd2). A simple shear test was performed to determine the shear strength at the interface at two test temperatures, 25°C (77°F) and 55°C (131°F). The influence of vertical load levels on interface bonding strength was evaluated using the optimum tack coat material and application rate. Based on the statistical analysis of the interface bond strengths provided by various tack coat types at different application rates, both CRS-2P and CRS-2L were identified as the optimum tack coat types among the eight tack coat types considered in this study. The preliminary test results indicated that CRS-2P emulsion provided the highest interface bond strength at the test temperature of 25°C (77°F), whereas CRS-2L provided the highest interface bond strength at the test temperature of 55°C (131°F), both at an optimum residual application of 0.09 l/m2 (0.02 gal/yd2). In addition, the shear resistance at the interface increased significantly with an increase in vertical load and decreased with an increase in temperature.

Title: Assessing heat-adhesive emulsions for tack coats
Author(s): Rodrigo Miro Recasens, Adriana Martinez, Felix Pee Jimenez
Date: February 2005
Source/URL: *Proceedings of the Institution of Civil Engineers: Transport*, Vol. 158 (1), February 2005: 45-51.
Description: 7 pp.
Contents: The use of conventional emulsions for tack coats can cause problems as they frequently stick to the tyres of construction vehicles. Consequently, the bond between the asphalt layers is inadequate. Recently, new types of

emulsions have been developed from very low-penetration bitumen that contain no flux. They are known as 'heat-adhesive' emulsions and they are resistant to construction vehicles. However, the adhesive ability of these new emulsions has not previously been studied closely, particularly at low temperatures. The purpose of this study is to analyse the effect of different heat-adhesive emulsions and to verify their performance in service in comparison with the response of a conventional emulsion. For this reason a new shear test—the LCB test—has been developed. This test is carried out at different temperatures, both on laboratory specimens and on cores extracted from recently constructed pavements, where the same emulsions and dosages have been used. It is the modified heat-adhesive emulsion that performs best over the selected range of temperatures. The conventional heat-adhesive emulsion, while performing well at medium temperatures, does not achieve the same resistance at the other temperatures as it is more temperature susceptible.

Title: Advanced testing and characterization of interlayer shear resistance
Author(s): Francesco Canestrari, Gilda Ferrotti, Manfred N. Partl, Ezio Santagata
Date: 2005
Source/URL: *Transportation Research Record No. 1929*, 2005: 69-78.
Description: 10 pp.
Contents: The performance of multilayered pavement systems depends strongly on interlayer bonding. To guarantee good bonding, tack coats (also called bond coats) are usually applied at various interfaces during pavement construction or overlay. The effectiveness of the tack coat can be assessed with the use of several devices arranged by different laboratories to evaluate interlayer shear resistance. This paper shows how interlayer shear resistance may be evaluated through the Ancona shear testing research and analysis (ASTRA) device. ASTRA results, expressed in units of maximum interlayer shear stress (τ_{peak}), highlight the effects of various influence parameters such as type of interface treatment, curing time, procedure of specimen preparation, temperature, and applied normal load. Moreover, this paper compares the τ_{peak} results obtained by two different shear test devices: the ASTRA tester designed and developed in the Polytechnic University of Marche (Italy) and the layer-parallel direct shear tester created by the Swiss Federal Laboratories for Materials Testing and Research. The two test methods provide different but comparable results showing the same ranking of shear resistance for different interface treatments.

Title: Development of a laboratory test procedure to evaluate tack coat performance
Author(s): Yetkin Yildirim, Andre de Fortier Smit, Armagan Korkmaz
Date: 2005
Source/URL: *Turkish Journal of Engineering and Environmental Sciences*, Vol. 29 (4), 2005: 195-205.
Description: 11 pp.
Contents: A laboratory testing procedure is presented, the results of which may be used for determining the best combination of tack coat type, mixture type, and application rate to be applied in the field for optimum performance. Tack coat related performance results were determined from Hamburg wheel tracking and simple shear tests on laboratory prepared specimens. This study was undertaken to evaluate the shear strength performance of tack coats under laboratory-controlled conditions. The performance of thin asphalt concrete (AC) overlays on concrete (PCC) pavements was evaluated. In practice, problems with these types of structures are often related to the interface interaction between the AC and PCC and consequently the performance of the tack coat. The experiment presents a methodology to examine the performance of tack coats used to bond AC and PCC structures in the laboratory. This paper presents the results of the lab tests and a statistical analysis of the results.

Title: Field Tack Coat Evaluator (ATACKer™)
Author(s): M. Shane Buchanan, Mark E. Woods
Date: December 2004
Source/URL: Mississippi Transportation Research Center Report No. FHWA/MS-DOT-RD-04-168.
http://www.gomdot.com/Divisions/Highways/Documents/Research/Reports/InterimFinal/SS168.pdf
Description: 124 pp.
Contents: Asphalt tack coats are applied during pavement construction to ensure bond between pavement layers, thus providing a more durable pavement. A prototype tack coat evaluation device (TCED) was developed to evaluate the tensile and torque-shear strength of tack coat materials. Three emulsions (SS-1, CSS-1, and CRS-2) and one asphalt binder (PG 67-22), commonly used as tack coats, were evaluated using the TCED at various application temperatures, application rates, dilutions, and set times. A laboratory bond interface strength device (LBISD) was developed to assess interface shear strength of laboratory prepared specimens. Mass loss testing was performed to evaluate moisture evaporation and visual breaking properties of emulsions. Study results indicate application rate, tack coat, and emulsion set time significantly affect TCED strength. Application rate also affected evaporation rate of emulsions.

Title: Assessment of bond condition using the Leutner shear test
Author(s): A.C. Collop, N.H. Thom, C. Sangiorgi
Date: November 2003
Source/URL: *Proceedings of the Institution of Civil Engineers: Transport*, Vol. 156 (4), November 2003: 211-217.
Description: 7 pp.
Contents: Pavement structures comprise several layers of different materials. The overall strength and stiffness of the pavement depends not only on the strength and stiffness of each individual layer, but also on the bond between them. Should the bond at an interface be inadequate, the strains throughout the pavement may increase (under trafficking) and its life may consequently be reduced. This paper investigates the use of the Leutner test to measure bond condition between surfacing and binder course materials and binder course and base materials. A range of bond conditions have been investigated. Results show that, for a particular combination of materials, there is an approximate linear relationship between interface shear strength and corresponding shear displacement that is independent of the bond condition. Results also indicate that, for HRA/ 20DBM, SMA/20DBM and 20DBM/28DBM combinations, the type and quantity of tack coat commonly applied in practice are sufficient to approach maximum attainable bond strength. For the 20DBM/28DBM combination a much reduced interface shear strength occurred if tack coat was not used, but extra tack coat appeared to compensate to some extent for the presence of dirt. In the 20DBM/CBM combination, it proved impossible to achieve a good bond, reflecting common experience on site.

Title: Influence of asphalt tack coat materials on interface shear strength
Author(s): Louay N. Mohammad, M. Abdur Raqib, Baoshan Huang
Date: 2002
Source/URL: *Transportation Research Record No. 1789*, 2002: 56-65.
Description: 10 pp.
Contents: Asphalt tack coat is a light application of asphalt, usually diluted with water. It is used to ensure a bond between the surface being paved and the overlying course. Normally, hot asphalt cements, emulsified asphalts, or cutback asphalts are used as tack coats. The objective of this study was to evaluate the practice of using tack coats through controlled laboratory simple shear tests and determine the optimum application rate. The influence of tack coat types, application rates, and test temperatures on the interface shear strength was examined. Four emulsions (CRS 2P, SS-1, CSS-1, and SS-1h) and two asphalt binders (PG 64-22 and PG 76-22M) were selected as tack coat materials. The residual application rates considered were 0.00 (0.00), 0.09 (0.02), 0.23 (0.05), 0.45 (0.1), and 0.9 (0.2) L/m^2 (gal/yd^2). A simple shear test was performed to determine the shear strength at the interface at two test temperatures, 25°C (77°F) and 55°C (131°F). The results indicated that CRS-2P emulsion was the best tack coat type and 0.09 L/m^2 (0.02 gal/yd^2) was the optimum application rate at which a maximum interface shear strength was measured for both test temperatures.

Title: Characterization of asphalt concrete layer interfaces
Author(s): Stefan A. Romanoschi, John B. Metcalf
Date: 2001
Source/URL: *Transportation Research Record No. 1778*, 2001: 132-139.
Description: 8 pp.
Contents: A new constitutive model for the asphalt concrete layer interface is proposed. Direct shear tests at four levels of normal load and three temperatures were performed on two types of asphalt concrete layer interface: with and without a tack coat. The shear stress-displacement curves determined in these tests were used to derive the constitutive model, as the tangential and normal stresses at the interface are decoupled. In the proposed model, the shear stress and displacement are proportional until the shear stress equals the shear strength and the interface fails. After failure, a friction model may be used to represent the interface condition. Three parameters were considered to completely describe the interface behavior: the interface reaction modulus *K,* which is the slope of the shear stress-displacement curve; the shear strength *S*-max; and the friction coefficient after failure m. For the interface with a tack coat, *K* and *S*-max are not affected by the normal stress level, but they are affected for the interface without a tack coat. All three parameters of the constitutive model are temperature dependent. A testing configuration for determining the shear fatigue behavior of the interface is also described. The fatigue tests indicated a linear increase of the permanent shear displacement with the number of load repetitions, the rate of increase being higher for higher stresses. The fatigue test can be used for a comparative evaluation of the durability of different types of interfaces.

Research in Progress

Results are listed chronologically, with the most recent citations shown first. Links to research project Web sites or TRB Research in Progress listings are provided when available.

Title: Optimization of Tack Coat for HMA Placement (NCHRP Project 9-40)
Principal Investigator(s): Louay Mohammad, Louisiana Transportation Research Center, (225) 767-9126
Start Date: 7/1/2005
RIP URL: http://rip.trb.org/browse/dproject.asp?n=10564
Sponsor Organization: NCHRP
Contents: A tack coat is typically applied just before a hot mix asphalt (HMA) layer or overlay is placed. A tack coat is a simple, relatively inexpensive process included as an incidental item in many HMA construction specifications. Indeed, a tack coat is so simple in concept that its real importance is often overlooked. An inadequate tack coat product or improper application of a good product can result in costly failure. A review of the extensive body of literature on tack coat materials and their use suggests that tack coats are placed to bond pavement layers together, with the intent of providing a monolithic, impermeable structure or preventing slippage of HMA overlays. However, these views on the function of a tack coat are not universally accepted. Studies conducted on the strength of interfaces in HMA pavements have shown that a strong tack coat bond between pavement layers is critical for transfer of radial tensile and shear stresses into the entire pavement structure. On the other hand, no tack coat bond or an insufficient bond decreases pavement-bearing capacity and may cause slippage. No bond or insufficient bond may also cause tensile stresses to be concentrated at the bottom of the wearing course. Such concentrated stress may accelerate fatigue cracking and lead ultimately to pavement failure. Few guidelines are available for proper selection of tack coat material type, application rate, and placement. Optimum tack coat type and application rate will be determined by the type and condition of the existing pavement surface as well as other factors including material type and permeability of the HMA pavement overlay to be placed, the traffic loading, and the climate. Proper, uniform tack coat application requires close attention to equipment calibration and operating parameters. The objectives of this study are to determine optimum application methods, equipment type and calibration procedures, application rates, and asphalt binder materials for the various uses of tack coats and to recommend revisions to relevant AASHTO methods and practices related to tack coats. In accomplishing these objectives, both present and emerging technology in the United States and worldwide will be evaluated.

Title: Evaluation of Bond Strength Between Paving Layers for Hot-Mix Asphalt
Principal Investigator(s): Kevin D. Hall, Arkansas State University, (501) 575-8695
Start Date: 7/1/2006
RIP URL: http://rip.trb.org/browse/dproject.asp?n=13255
Sponsor Organization: Arkansas State Highway and Transportation Department
Contents: Many premature pavement failures can be attributed to the loss of bond between two layers of hot mix asphalt (HMA). When the bond fails, slippage occurs and rutting and/or corrugations develop. There is a higher potential for failure at points where traffic is accelerating or decelerating, such as at signals and within horizontal curves. In many construction projects, successive layers of HMA are bonded using a tack coat. Asphalt cements, asphalt emulsions, and cutback asphalts have all been used as tack coats. In many cases, improved tack coats would eliminate or significantly reduce the potential for premature pavement failure due to loss of bond between HMA layers. It is well understood that the type of asphalt, grade of asphalt, and amount of tack coat affects the bond between layers. However, there is presently no standard method to evaluate the effect of these variables, and hence the potential of the variables to improve the bond between two HMA layers. This research seeks to develop a simple, quick, and relatively inexpensive test method to evaluate the bond strength between HMA layers. If poor interlayer bond can be detected prior to opening a pavement to traffic, steps can be taken to correct the problem. The result will be potentially significant savings in construction, maintenance, and rehabilitation costs.

Title: De-Bonding Cracking in Hot Mix Asphalt Pavement
Principal Investigator(s): Steve Muench, University of Washington, (206) 616-1259 or stmuench@u.washington.edu
Start Date: 7/1/2006
RIP URL: http://rip.trb.org/browse/dproject.asp?n=13323
Sponsor Organization: University of Washington
Contents: Recent evidence in Washington State, Hawaii and elsewhere indicates that a significant portion of cracking in thick hot mix asphalt (HMA) pavements is due to a previously uninvestigated phenomenon: bottom-up cracking of a de-bonded HMA surface layer. This cracking results when a surface HMA layer is not adequately bonded to underlying HMA layers (often through the inadequate or inappropriate use of tack coat) and behaves as an independent and extremely thin HMA layer. This de-bonding can shorten pavement life and cost agencies and

taxpayers substantial money. Evidence from other pavement studies suggest de-bonding is much more prevalent and influential than previously thought. Potential benefits include: an understanding of this failure phenomenon, better specifications and practice for tack coat application to combat this failure, and ultimately better pavements with lower life-cycle costs. This proposed study would be the first known investigation into the significance, prevalence and performance impact of what we are calling de-bonding cracks. We propose to work with the Washington State Department of Transportation (WSDOT) to identify and perform statistical and forensic analyses on pavements thought to suffer from de-bonding cracks. This effort will establish the relative significance and prevalence of de-bonding cracking and form the basis for future, in-depth research.

Title: Refinement of the Bond Strength Procedure and Investigation of a Specification
Principal Investigator(s): Randy West, National Center for Asphalt Technology, (334) 844-6228 or westran@eng.auburn.edu
Start Date: 8/29/2007
RIP URL: http://rip.trb.org/browse/dproject.asp?n=14863
Sponsor Organization: Alabama Department of Transportation
Contents: Many of the past studies on bond strength concentrated on only one depth to interface and a couple of tack coats. Research on the affect of aging and traffic on bond strength has also been minimal. Texture effects on bond strength have not been investigated as extensively as tack coat rate and type. Additional research on texture effects should be explored. The previous National Center for Asphalt Technology (NCAT) research indicated that milling aids in developing strong bond. There has been some research indicated that milling aids in developing strong bond. There has been some research concentrating on stress distributions within pavement layers and at an interface. The modeling techniques employed tend to vary. The proposed research will address some of these areas that have not been thoroughly addressed. Varying interface depths, aging, and exposed to traffic will be evaluated in the current research. One phase of the project will investigate the relationship between bond strengths of cores extracted immediately after construction and some time after. Another phase will use a modeling technique to better understand the stresses occurring at the interface and in the uppermost lift. An additional phase will be laboratory based evaluating tack coat types and applications with respect to bond strength.

Title: Bond Performance Expectations (and Requirements) for Hot Mix Asphalt Pavements
Principal Investigator(s): Kevin K. McGhee, Virginia Transportation Research Council, (434) 293-1956 or Kevin.McGhee@VDOT.Virginia.gov
Start Date: 7/23/2007
RIP URL: http://rip.trb.org/browse/dproject.asp?n=14310
Sponsor Organization: Virginia Department of Transportation
Contents: This research aims to identify a test method and acceptance criteria for bonding of hot mix asphalt (HMA) layers. It proposes to accomplish this through a phased process. The first phase will address the growing percentage of HMA resurfacing projects that involve milled original surfaces. In this phase, commonly used (and simple) tension and shear tests will be conducted to compare the bond strength of conventionally-tacked, non-tracking tack, and un-tacked interlayers for HMA resurfacing projects. The second phase will critically review the bond testing procedure(s) and begin to develop a recommended performance test method and initial bond strength for use with a comprehensive performance specification for HMA construction.